Development of a laboratory protocol for evaluating canning quality in dry bean

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Abstract

Results of studies on the effect of canning variables on canning quality traits were used to develop a modified laboratory protocol for evaluating canning quality of navy, black and pinto beans. Calcium concentration was inversely related to all traits, except texture and appearance. Blanching navy and pinto beans at 88°C and black beans at 70°C gave the highest percent washed drained weight (PWDWT). Thermal processing at 115.6°C for 45 minutes was essential to attain food safety and commercial sterility. The laboratory protocol resulted in lower means for quality traits than the industry protocol. The PWDWT was significantly different between protocols in pinto bean only. The laboratory protocol readily detected differences in various quality attributes among commercial seed samples within each bean class.

Introduction

Dry bean ***(Phaseolus vulgaris*** L.) is the most important food legume crop in the world. In Canada, it is worth more than $60 million dollars annually (Park and Buzzell, 1995). On the prairies beans are produced on over 33,000 hectares, and most of them are sold for canning. Thus, good canning (cooking) quality is essential since a bean cultivar with poor culinary quality will be rejected by consumers and processors, regardless of how agronomically superior it is. Accordingly, elite genetic stock should be evaluated for improved culinary quality together with agronomic traits. The canning process involves many variables , such as the calcium concentration in the soak water , blanch water and brine; hydration temperature; bean solids per can; and cooking time and temperature for food safety and sterility. All of these variables influence the quality traits of interest, such as hydration coefficient (HC), washed drained weight (WDWT), percent washed drained weight (PWDWT), texture (TEXT), colour (COL), degree of clumping (CLMP), appearance (APPEAR) and viscosity of the sauce (VISC) in canned dry bean samples. According to the government regulations , PWDWT should be no less than 60%. TEXT, COL, CLMP and APPEAR are related to consumer preference.

Industry hydrates the bean seeds by soaking them overnight and then blanches them at 70°C for 4 minutes. This process demands time and storage space and does not enable the quality specialists to modify the process for individual lots. An alternate protocol was developed at the Michigan State University (MSU) which involves soaking bean seeds for 30 minutes at room temperature, and then blanching them for 30 minutes at 88°C. The water used in the MSU protocol contains 100 ppm calcium. The remaining

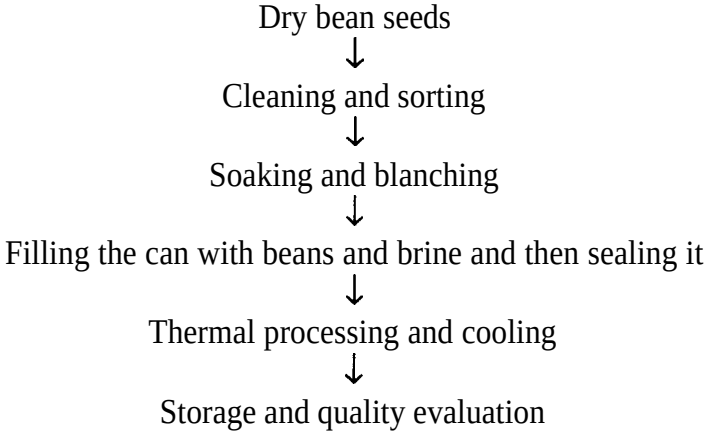
processing steps are the same for both methods. This laboratory protocol provides a more readily controlled schedule and requires less storage space.

A major concern in the genetic improvement of quality traits in beans is the genotype-by- environment interaction since the canning traits are strongly influenced by environment (Ghaderi *et al.*, 1984; Hosfield, 1991). The objectives of this study were to develop a laboratory protocol that best addressed the quality requirements of the Canada Agricultural Products Standards Act and simulated the actual industrial process and to determine the effects of genotype, environment , and the genotype by environment interaction on canning traits.

Materials and Methods

Samples of navy bean cv. Avanti, black bean cv. UI 906 and an unidentified pinto bean were used in this study. However, for the preliminary soaking study, pinto bean cv. Othello was used instead of the unidentified cultivar. The basic steps in the canning process are shown in Figure 1. The effect of canning variables, such as calcium concentration in the soak water, blanch water and brine; hydration temperature; bean solids per can; cooking time and temperature for food safety and sterility, on canning quality traits was studied using the laboratory protocol.

Figure 1. Schematic diagram of the canning process for dry bean seeds.



HC was determined as the ratio of weight of soaked bean seeds to the weight of dry bean seeds, WDWT and PWDWT was determined as per the government regulations in the Canada Agricultural Products Standards Act, TEXT was determined by using the Kramer shear press and subjective traits CLMP and APPEAR were rated on a 1 to 3 scale and 1 to 5 scale respectively, with lower values indicating the acceptable range. The final laboratory protocol, based on the study of the effects of individual canning variables, was then compared with the industry protocol (Sprague Foods Ltd., Ontario). The laboratory protocol was then applied on commercial seed samples of navy, black and pinto bean classes to determine possible differences between and within commercial

class. In all cases, canned bean seeds were stored for two weeks prior to quality evaluation. In addition, samples of commercially canned navy, black and pinto beans were purchased from various outlets and quality traits evaluated.

Results and Discussion

Quality traits were significantly affected by various calcium concentrations in the soak water, blanch water and brine. In all bean classes, calcium concentration was inversely related to all traits, except TEXT and APPEAR (Table 1). Thus, PWDWT and TEXT are inversely related. The 10 ppm calcium in the soak water, blanch water and brine allowed maximum hydration of the bean seeds and gave the highest PWDWT with a reasonable mean for TEXT.

Table 1. Effect of calcium concentration in the soak water, blanch water and brine on quality traits in navy bean cv. Avanti.

	Quality trait					
Ca ppm	HC	WDWT	PWDWT	TEXT	CLMP	APPEAR
0	1.873a[z]	301.3a	67.7a	33.1f	3.0	5.0
10	1.850b	283.4b	63.1b	39.4e	3.0	5.0
20	1.829c	279.6bc	62.6bc	46.9d	3.0	4.0
22.2 (tap water)	1.804e	274.6bc	61.7bc	60.2c	2.0	4.0
30	1.814d	276.0bc	61.7bc	59.6c	2.0	4.0
40	1.809d	274.9bc	61.9bc	65.7b	1.5	4.0
50	1.791f	273.0c	60.7c	79.1a	1.0	4.0
L.S.D.	0.009	9.3	2.1	2.6	ns	ns

[z]Means within each column followed by the same letter do not differ at the 0.05 level.

After the initial 30 minute soak at room temperature, blanching navy and pinto beans at 88°C and black beans at 70°C gave the highest PWDWT. The processing study also revealed that weighing 96, 97, and 95 grams of bean solids (moisture-free basis) per can, respectively, for navy, black and pinto beans was sufficient to meet the government regulation for PWDWT. Processors prefer bean cultivars that need a lower weight of seed to achieve 60% for PWDWT. Food safety and sterility are the two major concerns of any canned, low-acid (pH > 4.5) foodstuff (Stumbo et al., 1983). The therrnal processing time, as determined by the Ball method at 115.6°C for 14 fl oz (300 X 407) cans in the still retort, was 45 minutes for both the laboratory and industry protocol. The details of the resulting laboratory protocol are presented in Table 2.

In the comparison study, the laboratory protocol resulted in lower means for quality traits than the industry protocol (Table 3). The PWDWT was not significantly different

between protocols for navy and black beans, but was lower for pinto beans using the laboratory protocol.

Table 2. Summary of the laboratory protocol for navy, black and pinto bean classes.

Bean class	Solids (g)	Soaking	Blanching	Thermal processing	Cooling
Navy	96	30 min at 22°C	30 min at 88°C	45 min at 115.6°C	20 min at 20°C
Black	97	30 min at 22°C	30 min at 70°C	45 min at 1156°C	20 min at 20°C
Pin to	95	30 min at 22°C	30 min at 88°C	45 min at 115.6°C	20 min at 20°C

Table 3. Comparison of laboratory and industry protocol for PWDWT in navy, black and pinto beans.

Bean class	PWDWT	
	Laboratory protocol	Industry protocol
Navy	60.2 ± 0.3	60.5 ± 0.4
Black	59.8 ± 0.3	60.0 ± 0.3
Pinto	59.9 ± 0.2**	60.9 ± 0.2"

"Significant at the 1% level.

Quality evaluations on commercial bean seed samples canned using the laboratory protocol showed that the laboratory protocol distinguished between commercial classes and detected differences in quality traits between samples within each bean commercial class (Table 4). Several samples of commercially canned beans failed to meet the government regulations for PWDWT. As the storage time increases, the bean seeds start losing their solids into the surrounding brine, and this may have accounted for their low PWDWT.

Table 4. Quality evaluation of commercial seed samples of black bean canned using the laboratory protocol.

Samples	Quality trait					
	HC	WDWT	PWDWT	TEXT	CLMP	APPEAR
UI 906	1.533d[z]	265.4a	59.8a	79.4a	3.0	3.0
CDC Nighthawk	1.900a	267.5a	60.0a	62.0c	2.5	2.0
CS[y]1	1.749c	264.4b	59.4a	73.7b	2.0	3.8
cs 2	1.798b	269.0a	60.5a	48.3d	2.5	3.0

'Commercial samples.
'Means within each column followed by the same letter do not differ at the 0.05 level.

The laboratory protocol will be used on seed samples from the Saskatchewan dry bean regional trials in 1995 and 1996 to study the effects of genotype, environment and the genotype by environment interaction on canning traits.

Conclusions

The 10 ppm calcium concentration in the soak water, blanch water and brine together with a high blanching temperature reduced the hydration time from overnight to 1 hour. The mean for PWDWT of dry beans canned using the laboratory protocol was significantly lower than from dry beans canned using the industry protocol only for pinto bean. Nevertheless, the laboratory protocol provides an excellent test for canning quality of dry beans. The laboratory protocol will enable bean breeders to screen advanced breeding lines for quality attributes so that only high quality cultivars are released.

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